ABSTRACT

Experiencing the Expansion of the Universe: A Secondary Teacher Masterclass on Astrophysics and Cosmology

Kristina Lubinski (DePauw University, Greencastle, IN 46135), Chris Stoughton (Fermi National Accelerator Laboratory, Batavia, IL 60510).

Secondary physics teachers are always trying to expand their knowledge as the different fields of physics are expanding their data and findings. We planned a masterclass titled "Experiencing the Expansion of the Universe" for fifteen high school physics teachers in Illinois. As teachers, we believe, accept, and teach most scientific facts that Fermi National Accelerator Laboratory scientists tell us. Why should we believe them though? The purpose of the masterclass was to give high school teachers a solid understanding of the expanding universe by allowing them to experience the data and analysis themselves. This gave the teachers a chance to develop the critical skills needed to evaluate credibility of scientific claims. The teachers experienced the expansion of the universe in three ways. All three methods were grounded in the assumption that the universe began as a very small, hot, and dense object. First, they analyzed magnitude and redshift of galaxies to form Hubble diagrams and to graphically see the expanding universe. They also derived the Hubble constant to 10% accuracy. Second, they analyzed the spectrum of different blackbodies and fit curves to find the temperature of said blackbodies. Eventually they analyzed the COBE cosmic microwave background spectrum to see that the universe is a perfect blackbody with a temperature of about 2.75 Kelvin. Finally, they examined the results of Big Bang nucleosynthesis. Applying all the laws of physics from right after the Big Bang forward, they saw that the universe should be about 25% helium. By analyzing the spectrum of five stars (data from Sloan Digital Sky Survey), they witnessed for themselves the 25% mass ratio of helium in the universe. In addition to showing teachers how to access and analyze the data, we had an expert scientist for each of the exercises to relate how they personally experienced the observations. The teachers were able to experience the expansion of the universe and discuss ways to make these lessons and ideas relevant in their classrooms.